Prospect / Retrospect

It is estimated that close to 1000 electrical accidents occur in the industry every year. Accidents involving electricity can lead to burns and tissue damage and in some cases, cardiac arrest and death. Electric shock can be very unsettling to the victim even if there is no apparent injury.

The most common causes for electrical accidents are faulty wiring, badly designed equipment, poor work practices and most significantly, exposed live parts. While only qualified personnel work on electrical switchboards, there could be situations when working on a part of the switchboard, they accidentally access a live part or a fault occurring in some other area, travels to the area where they are working. It is to avoid such situations that internal separation between the various functional areas has to be provided. International standards have recognised this as a very important criteria in switchboard design and have defined different Forms of Separation. Depending on the switchboard location, application and economic considerations, customers can opt for the appropriate Forms of separation. This issue of Current Trends describes in detail how Forms of Separation can provide a safe solution.

Forms of Separation in LV Switchboard

Forms of separation refer to the internal segregation provided.

As per IEC 60439-1, “Separation of the various elements of an Assembly: busbars, functional units, terminals, can be claimed providing one or more of the following criteria are met:

1. Protection against contact with live parts belonging to adjacent functional units. The degree of protection shall be at least IP2X or IPXXB.

2. Protection against the passage of solid foreign bodies from one unit of an Assembly to an adjacent unit. The degree of protection shall be at least IP2X”.

To implement these two conditions, IEC classifies Forms of separation in four categories

- **Form 1:**
  - No internal separation provided.
  - (refer pic. 1)
  - Busbars are not separated from other functional units
  - Functional units are not separated from other functional units
  - Functional units are not separated from any incoming or outgoing termination

- **Form 2:**
  - Busbars are separated from other functional units

Busbars are not separated from any incoming or outgoing terminations

This Form of separation is generally used in applications where the switchboard is in a secure location where there are no chances of accidental contact with the switchboard or in locations where the switchboard is not critical to the process and maintenance activity on switchboard will not result in production loss.

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- Swathi Rangarajan
  Central Marketing Team
Functional units are not separated from other functional units

Functional units are separated from any incoming or outgoing terminals.

Form 2a: Terminals of external conductors not separated from busbars (Refer pic. 2a)
Form 2b: Terminals of external conductors separated from busbars (Refer pic. 2b)

Form 2 separation is used for applications like that of Form 1 but Form 2 switchboards offer advantage that functional units are not damaged for any fault in the bus bar.

Separation can be achieved in several ways. Depending on a particular application and the requirements for maintenance, this may include:

- PVC sleeving, wrapping or plastic coating of conductors
- Insulated terminal shields or PVC boots
- Rigid insulated barriers or partitions
- Compartments formed from earthed metal
- A device’s integral housing

IEC does not specify the material that is used for separation of barriers. However, BS standards, BS EN 60439 Part 1, has a classification based on the same.

Form 2b separation can be classified in two types:
Type 1 when the busbars separation is achieved by insulated covering like PVC sleeving, wrapping or coating.
Type 2 when rigid metallic or non-metallic barriers are used to achieve separation.

Form 3:
- Busbars are separated from other functional units
- Functional units are separated from other functional units
- Functional units are separated from incoming or outgoing terminals
- Ac and outgoing terminals are separated from each other

Form 3a: Terminals of external conductors not separated from busbars (Refer pic. 3a)
Form 3b: Terminals of external conductors separated from busbars (Refer pic. 3b)

Form 3 separation should be applied where it is important to provide protection from internal live parts and where failure of functional units being fed from the same busbar would cause unacceptable disruption.

As per BS standards, Form 3b can be classified into Type 1 and Type 2 depending on whether insulated coverings (Type 1) or rigid metallic/ non-metallic barriers (Type 2) are used to achieve separation of the bus bars.

Form 4:
- Busbars are separated from other functional units
- Functional units are separated from other functional units
- Functional units are separated from any incoming or outgoing terminals
- Ac and outgoing terminals are separated from each other

Form 4a: Terminals for external conductors in the same compartment as the associated functional unit (Refer pic. 4a)
Form 4b: Terminals for external conductors not in the same compartment as the associated functional unit, but in individual, separate, enclosed protected spaces or compartments. (Refer pic. 4b)

Form 4 separation should be applied where it is important to provide protection from internal live parts and where failure of functional units being fed from the same busbar would cause unacceptable disruption. Since all the terminations are separated, it is possible to isolate and work on a single functional unit.

RS EN 60439 Part 1 specifies the classification as Type 1 to Type 7 for Form 4. Depending on the specific requirement and need, it may not be enough to specify Form 4b; there needs to be further investigation as to which type is being provided.

Form 4, type 1 (equivalent to Form 4a):
- Busbar separation is achieved by insulated coverings, e.g. sleeving, wrapping or coatings
- Cables may be ganged elsewhere

Form 4, type 2 (equivalent to Form 4a):
- Busbar separation is by metallic or non-metallic rigid barriers or partitions
- Cables may be ganged elsewhere

Form 4, type 3 (equivalent to Form 4a):
- Busbar separation is by metallic or non-metallic rigid barriers or partitions
- Cables may be ganged elsewhere

Form 4, type 4 (equivalent to Form 4b):
- Busbar separation is achieved by insulated coverings, e.g. sleeving, wrapping or coatings
- Cables may be ganged elsewhere
- Busbar separation is by metallic or non-metallic rigid barriers or partitions
- The termination for each functional unit has its own integral glancing facility

The higher forms of protection thus ensure operating personnel safety as well as prevent any fault from spreading to other compartments. The maintenance time is also low since only the necessary modules need to be switched off and other modules in the same panel can continue to be operated. Replacement or rewiring can also be carried out in the minimum possible time.

While in Form 3, the end user has to rely on the manufacturer to offer isolation of live parts through use of shrouds, insulating materials, etc. In Form 4 separation there is an assurance of inherently safe switchboard.

Cables may be ganged elsewhere

Form 4, type 5 (equivalent to Form 4b):
- Busbar separation is by metallic or non-metallic rigid barriers or partitions
- Terminals may be separated by insulated coverings and ganged in common cabling chamber(s)

Form 4, type 6 (equivalent to Form 4b):
- All separation requirements are by metallic or non-metallic rigid barriers or partitions
- Cables are ganged in common cabling chamber(s)

Form 4, type 7:
- All separation requirements are by metallic or non-metallic rigid barriers or partitions
- The termination for each functional unit has its own integral glancing facility
Form 4 separation should be applied where it is important to provide protection from internal live parts and where failure of functional units being fed from the same busbar would cause unacceptable disruption. Since all the terminations are separated, it is possible to isolate and work on a single functional unit.

RS EN 60439 Part 1 specifies the classification as Type 1 to Type 7 for Form 4. Depending on the specific requirement and need, it may not be enough to specify Form 4b; there needs to be further investigation as to which type is being provided.

Form 4, type 5 (equivalent to Form 4b):
- Busbar separation is by metallic or non-metallic rigid barriers or partitions
- Cables are ganged in common cabling chamber(s)

Form 4, type 6 (equivalent to Form 4b):
- All separation requirements are by metallic or non-metallic rigid barriers or partitions
- Cables are ganged in common cabling chamber(s)

Form 4b, type 7
- All separation requirements are by metallic or non-metallic rigid barriers or partitions
- The termination for each functional unit has its own integral glazing facility

The higher forms of protection thus ensure operating personnel safety as well as prevent any fault from spreading to other compartment. The maintenance time is also low since only the necessary modules need to be switched off and other modules in the same panel can continue to be operated. Replacement or rewiring can also be carried out in the minimum possible time.

While in Form 3, the end user has to rely on the manufacturer to offer isolation of live parts through use of switchboards. Insulating materials, etc., in Form 4 separation there is an assurance of inherently safe switchboard.
Separation of the bus bars from the functional unit

The outgoing terminals of the functional modules are separated from each other

Inside the module

Outgoing stabs – Polycarbonate shrouds